

# Pastoral & Feedlot Systems.

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## User Manual 0121 Nutridose Controller with conductivity probe

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A	Original Issue	05-JUN-2006	Frank Thomson
B	Draft notification removed. Section 9 - Fixed cross reference to section 12 for the description of the function of each LED. Deleted heading 9.3.	28-AUG-2006	Frank Thomson

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# 1 Introduction

The Nutridose system is used to add a controlled amount of urea to the drinking water for cattle.

Typically a dose of 1% (100ml dose of urea concentrate per 10 litres of water) is used. Obtaining the correct dose is critical as even a small under-dose renders the system almost useless and a dose twice the required amount can kill cattle.

A number of factors can cause an overdose situation to occur. These include:-

- 1 The urea concentrate can be accidentally prepared at the wrong strength.
- 2 The system can malfunction and inject for too long a period
- 3 The water meter on the main water line can falsely trigger the dosing system.

Pure urea in water is not conductive however the urea mix includes salts that do increase the conductivity of the water.

The 0121 Nutridose controller includes a toroidal conductivity probe that measures the conductivity downstream of the injection point. The advantage of the toroidal probe is that there is no metal contact with the water. This means that there is much less chance of the probe measuring incorrectly due to a buildup of deposits on the probe.

This document is the user manual for operating the Nutridose controller.

This is a complicated and sophisticated system. Please take the time to read and understand this manual. If you have any questions, please contact the supplier. Ensure that you understand how the system works and the risks of using urea medication before using the process or this equipment.

## 2 Safety and Warnings and disclaimers

### 2.1 Urea warning

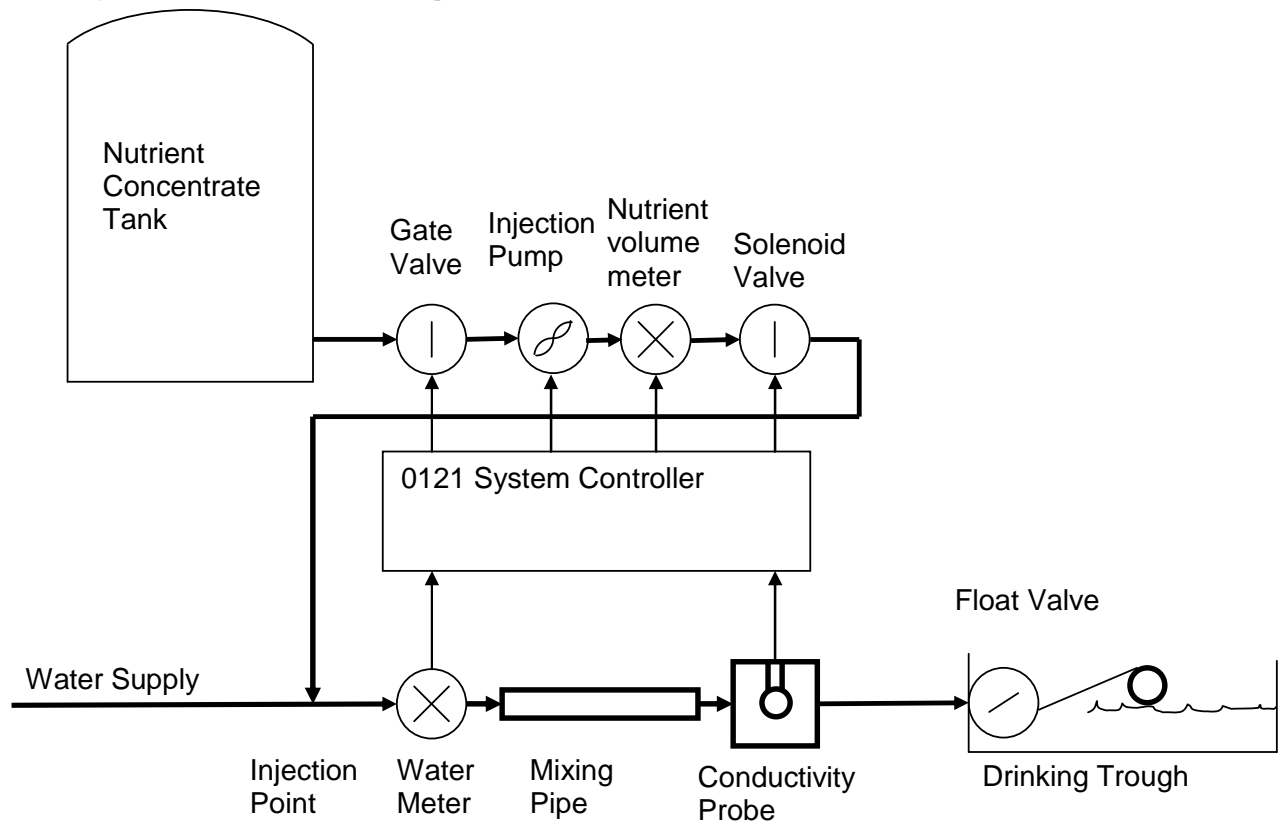
Too high a concentration of urea can kill cattle. Many safety interlocks have been included into this controller to try to protect against incorrect dosage. However there is NO guarantee that the system is fail safe. In the event that the 0121 controller shuts the system down the complete system should be examined to determine the source of the fault.

Regular maintenance of the system, especially moving parts is essential for reliable system level operation. Do not rely on software interlocks in the 0121 controller to compensate for faulty or poorly maintained hardware in the rest of the system.

### 2.2 Static Sensitive Components

The 0121 controller contains electronic components that are sensitive to static electricity. The unit should not be dismantled in the field and should only be opened at a static safe work station.

### 3 System Block Diagram

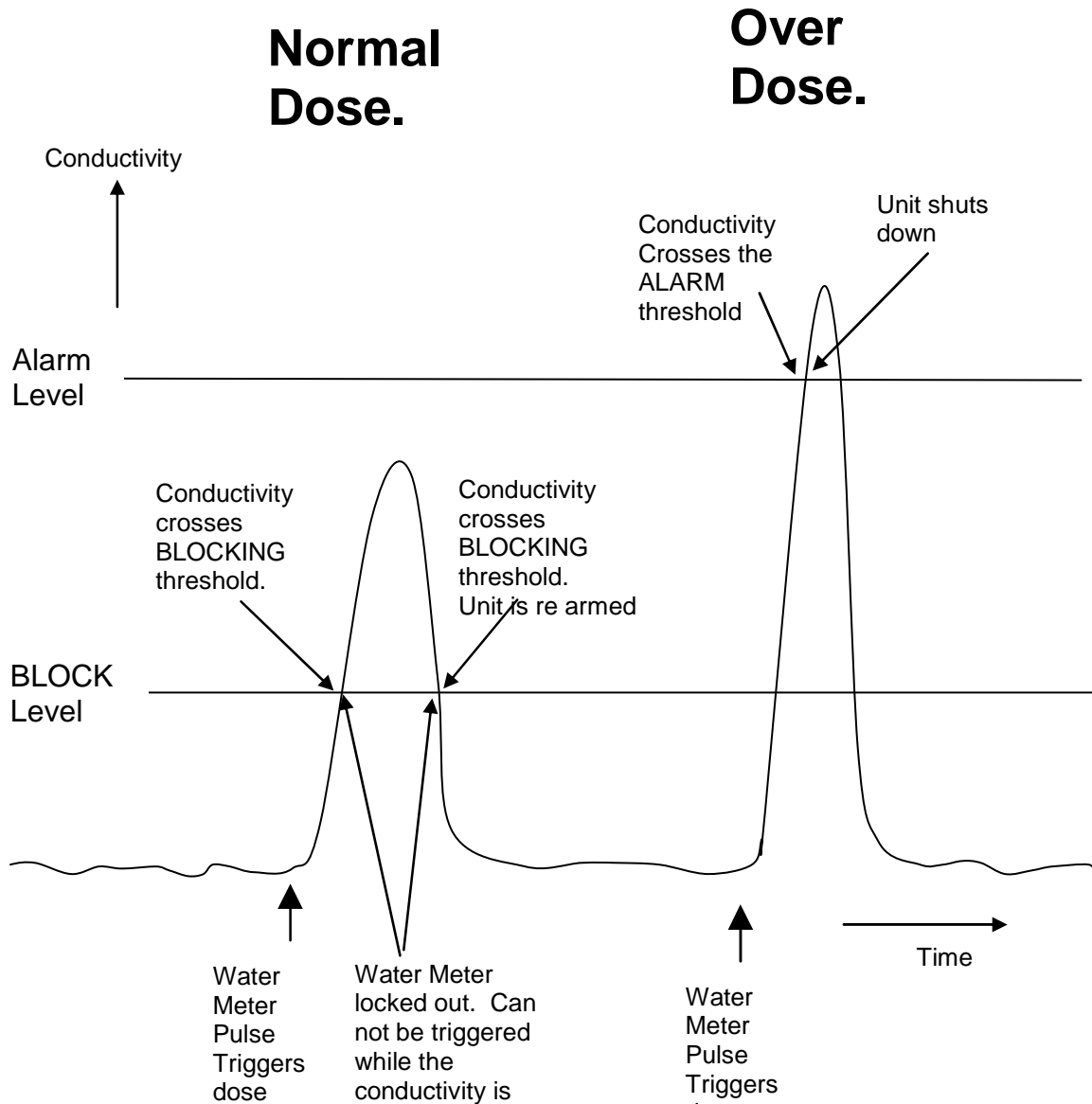


### 4 System Operation

The system operates as follows. When the cattle start to drink from the trough, the water float valve opens and the water flows in the line. The water meter measures the flow and every ten litres it sends a pulse to the controller. The controller is triggered by the pulse from the water meter and operates the injection pump to inject a measured dose into the water supply. The Nutrient volume meter is used to measure the dose and the pump time is adjusted to ensure that the correct dose is made. This helps to compensate for varying back pressures.

The water with the 100ml urea dose flows through the mixing pipe. This pipe will vary from installation to installation depending on flow rates.

The conductivity probe measures the conductivity of the mixture.



When the conductivity is below the warning threshold, the system is armed to receive a pulse from the water meter. When the pulse arrives, the system starts the dosing pump and injects a single 100ml dose. As the water flows through the mixing tube the dose mixes with the water so that a short time later the conductivity begins to rise. When the conductivity is above the warning threshold, the system locks out the water meter so that it can not get re triggered. As the water continues to flow, the conductivity increases until it reaches a maximum and then dies away. When the conductivity falls below the warning threshold, then the system is re armed and will be triggered by a water meter pulse.

If the dosing mixture is too strong or if the pump has run too long such that the maximum conductivity level crosses the alarm threshold, then the system shuts down.

## 5 Control Modes

The 0121 controller can operate in one of two fundamental modes.

### 5.1 *Nutrient Meter Dosing Mode*

This is a dynamic feedback control mode. In this mode, the actual dose is measured on every dose via the nutrient flow meter. The time that the pump is on is then adjusted to ensure that the correct dose is injected each time. This mode is useful when the Nutridose is connected to a manifold that distributes water to several paddocks in a way where the back pressure changes from day to day.

A risk with this mode is that if the Nutrient flow meter becomes faulty then the system can over dose.

In some water supply situations, the nutrient flow meter can become calcified. This initially shows up as intermittent operation with the occasional pump on too long alarm. This means that too much nutrient has been dosed. Whenever the system trips out, the user should fully investigate the reason for the trip out. Do not simply press the go button.

### 5.2 *Timer Mode*

In the timer mode, the unit runs the pump for the same constant time duration for each injection.

This has the advantage of simplicity and reliability however careful attention must be paid to ensure that the water pressure remains constant otherwise an under or overdose situation can occur.

## **6 Built in Safety and Monitoring functions**

The 0121 controller has a number of built in interlocks to try to limit the damage in the event of failure of components in the system. However these interlocks should not be used to compensate for poor system performance or as an excuse for a lack of maintenance.

### **6.1 *Maximum Pump On Time***

Irrespective of the other settings, the maximum time that the pump can be switched on is approximately 3 seconds when dosing and 15 seconds when the prime button is held down.

This is hard coded into the software and the user can not disable it.

### **6.2 *Conductivity Water Meter Lock out***

There are two thresholds that the user can enter that relate to conductivity. These are set in the CONFIG Menu. When the conductivity is above the level set in the COND BLOCK LVL, the controller will ignore pulses from the water meter. Note that the Conductivity Monitor must be enabled for this to work.

### **6.3 *Conductivity Alarm***

If the conductivity is above the level set in the COND ALARM LVL, the controller will trip out and shut down. Note that the Conductivity Monitor must be enabled for this to work.

### **6.4 *Nutrient Meter Health***

The nutrient meter produces a thousand or so pulses per litre. During the middle of each dose, the 0121 looks at the pulses and if the pulses become erratic such that no pulses are received for about 24ms that the system will shut down and report a CHECK NUTRIENT SENSOR alarm.

### **6.5 *Double water meter pulse***

If a second water meter pulse is received from the water meter while the solenoid and pump are enabled, ie while the system is dosing, then the system will shut down. Please note that if a conductivity sensor is used then the water meter is locked out when the conductivity is above the BLOCK threshold setting and so a second water meter pulse in this situation is ignored.

## **7 A Few Points to Bear In Mind**

If the mixing tube is too short then the urea will not have time to mix with the water and the conductivity will be high. It becomes difficult to distinguish between a normal dose and a dose where the pump has run too long.

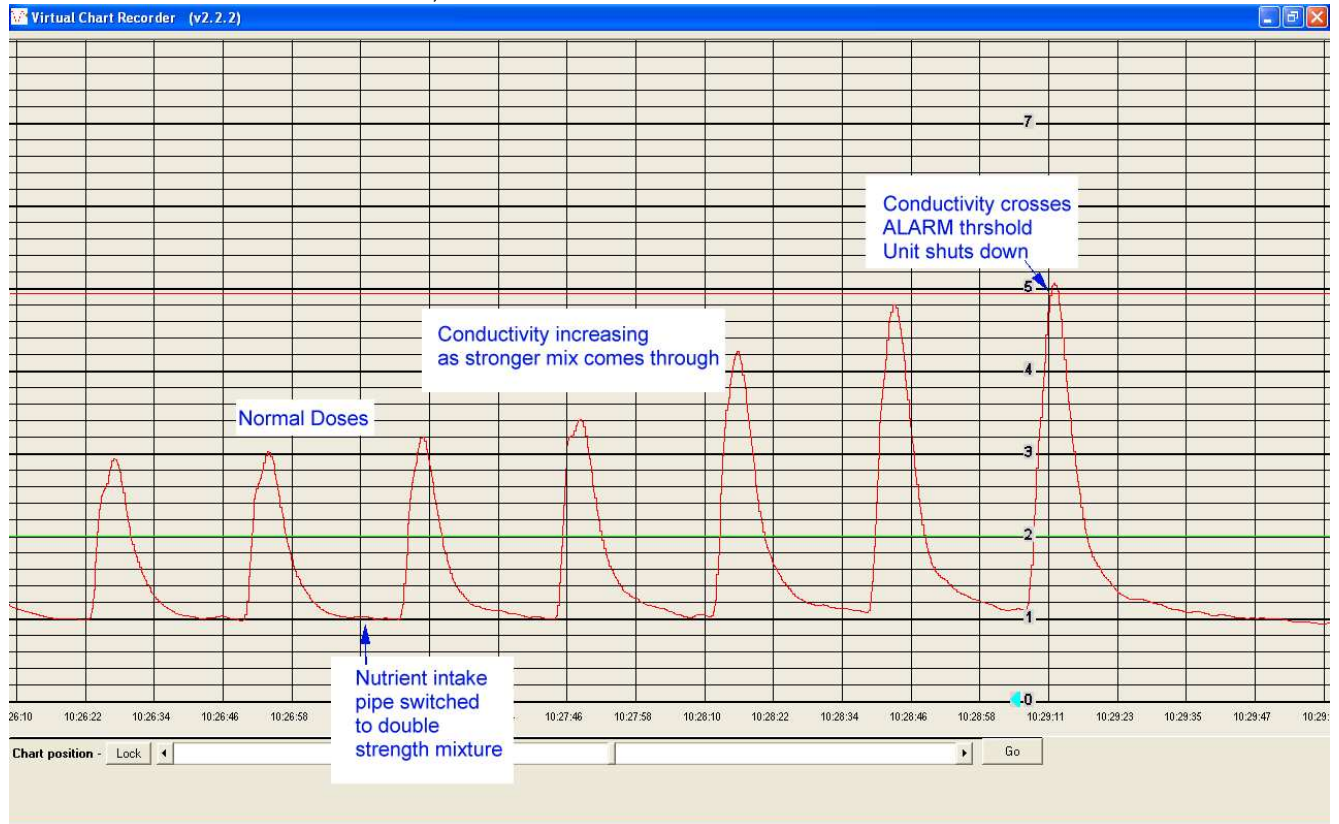
If the mixing tube is too long then the conductivity pulse will not be much higher than the background level and the alarm and warning thresholds will have to be set low and close



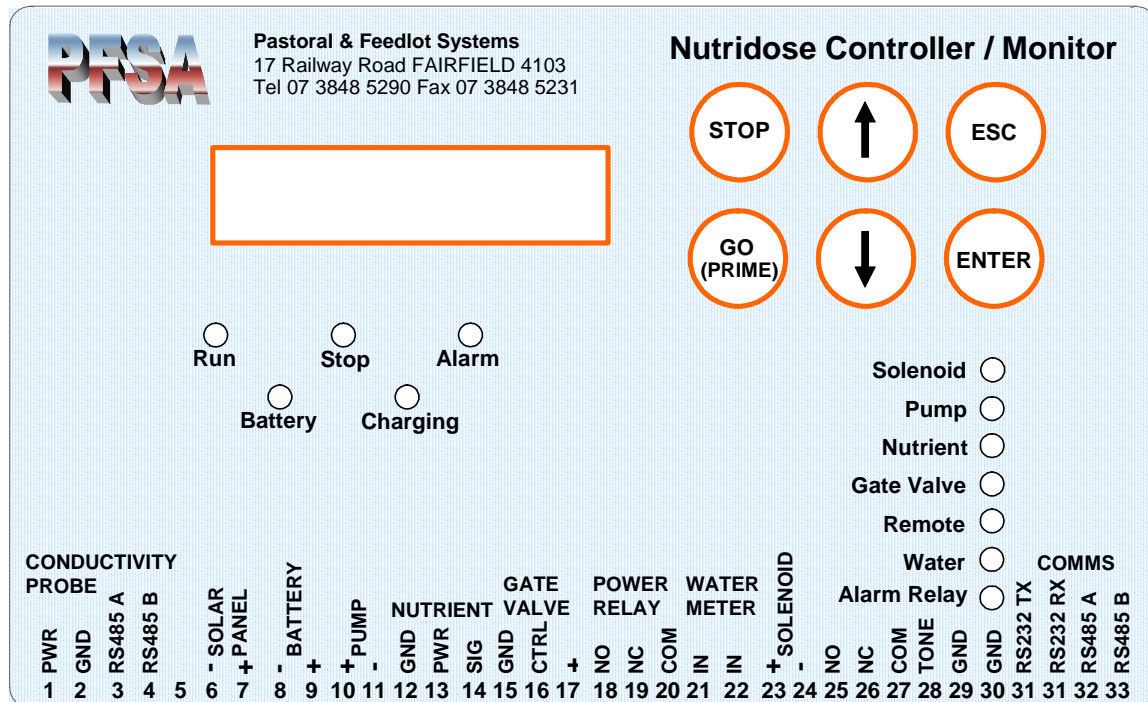
together. This may result in the system either shutting down unnecessarily or missing over dose situations.

## 8 Some real data

This test was done with two tanks of nutrient mix. One tank had the correct concentration and the other tank was filled with a mix that had been made up at twice the normal strength. At the point shown on the chart, the nutrient feed pipe was switched from one tank to the other. As you can see it took a number of doses for the stronger mix to flow through the system. Once the concentration crossed the threshold, the unit shut down.



## 9 0121 Control Unit Operation



There are some differences between the new Nutridose controller designated 0121 and the old Nutridose controller designated 0021 which did not have conductivity measurement capability.

For a detailed description of the function of each LED see section 12

### 9.1 Starting and Stopping

Pressing the GO button starts the system. The 0121 will open the gate valve and when a water meter pulse is received, the system will start the pump and deliver a dose of nutrient. To prime the pump, press and hold the Go button. The RUN LED will be lit.

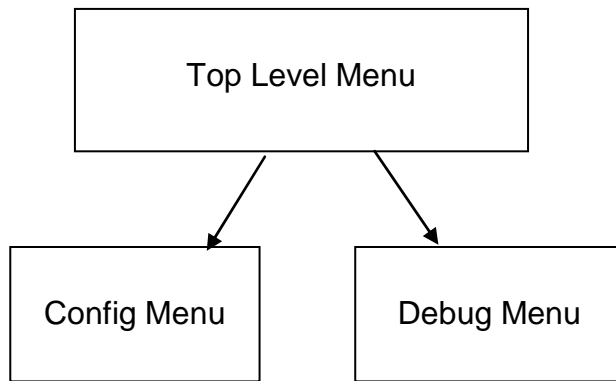
To stop dosing press the STOP button. The system will close the gate valve and will not operate the pump. The STOP LED will be lit indicating that the system has stopped.

If an alarm condition occurs then the system will shut down and the ALARM LED will light.

### 9.2 Using the LCD and Entering Data

Use the up and down arrow keys to scroll through the menus. The unit has two levels of menus. There is the top level menu that displays key information. The Config menu is used to enter data such as the dose time or percentage concentration and the alarm levels and other parameters. The DEBUG menu is used to view various things such as the actual measured conductivity.

To select an item press the ENTER button. To stop entering data press the ESC button.



## 10 Telemetry and Remote Control

The unit retains the serial remote control interface. The D-Type connector has been changed to a Phoenix screw terminal connector and now both RS232 and RS485 physical interfaces are provided.

The standard status string that the unit produces has been expanded to include the conductivity measurement and a new command has been added to stream conductivity data to the PC for plotting or analysis.

## 11 Monitoring Other Systems

This unit can be used to monitor an external dosing system and to shut it down in the event of an overdose situation being detected.

There are several ways to this. The power to the external system can be switched through the "Power Relay" on the 0121. For additional safety, a gate valve can be added to the system and controlled by the 0121.

### 11.1 Conductivity Probe Interface

The conductivity probe communicates via a RS485 physical interface. The conductivity interface is completely separate from the remote control interface.

Additional information on the remote interface will be provided in the manual.

## **12 Appendix 1 LEDs**

This section describes in detail the function of each LED on the unit.

### **12.1 RUN LED**

GREEN.

ON indicates that the system is in automatic mode and that nutrient is being injected at the correct level.

### **12.2 STOP LED**

RED

ON indicates that the unit has stopped by the operator pressing the stop button or a STOP command being received over the remote control interface.

### **12.3 ALARM LED**

RED

ON indicates that there is a problem either with this box or with the system being monitored. The reason for the ALARM LED being ON will be displayed on the LCD. This LED is a latched alarm and the user must press the GO button to restart the system.

### **12.4 Battery LED**

GREEN

On indicates that +12V battery is connected to the system.

### **12.5 CHARGING LED**

GREEN

The 0121 unit contains a solar panel regulator circuit to control the charging of a lead acid battery from a solar panel. The LED is on when the internal FET switch is closed and the solar panel is connected to the battery and therefore charging it. The unit measures the battery voltage and switches OFF when the voltage reaches 13.8V.

ON means the battery is being charged at the full rate.

FLASHING means the battery is being float charged at 13.8V.

### **12.6 Solenoid LED**

GREEN

On indicates that the Solenoid is energized. This LED will light momentarily before the pump starts.

### **12.7 Pump LED**

GREEN

On indicates that +12V is being supplied to the Pump.

**12.8 Nutrient LED**

GREEN

On indicates that the signal from the nutrient meter (pin 14) is high.

This LED will flash as nutrient is injected.

**12.9 Gate Valve LED**

GREEN

On indicates that the Gate Valve is OPEN.

**12.10 Remote LED**

GREEN

On indicates that Power Relay is energised. That is pin 18 is connected to pin 20. This relay is energised whenever the unit is in RUN mode and it is de energised when the unit is in STOP mode or ALARM Mode.

**12.11 Water LED**

GREEN

On indicates that the reed switch in the main water meter is closed. This LED normally flashes as the water flows through the meter. At the same time the slave relay connected between pins 18 and 19 is closed.

**12.12 Alarm Relay LED**

RED

ON means that the Alarm Relay is ENERGISED and that pin 25 is connected to Pin 27. This would normally be used to key a telemetry transmitter.

## 13 Appendix 2 Menu System

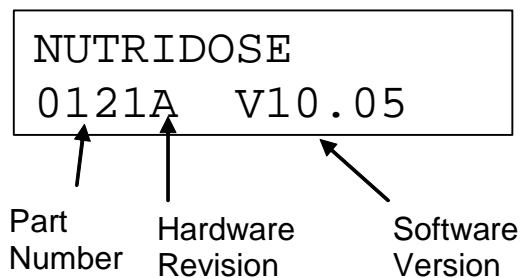
This appendix describes the Liquid Crystal Display (LCD) menu system.

### 13.1 Navigating the Menus

Use the up and down arrow keys to move from one menu display to the next.

To select or modify an item, press the ENTER button. If the item can be adjusted, then square brackets will be placed around the item. If you make a mistake and do not wish to change item, press the ESC key. ESC stands for Escape and it means escape or cancel from this item and go back to where you pressed the ENTER button.

### 13.2 Top Level Menu



When power is applied, the unit will display a start up screen as shown below. Press the down arrow to get to the next menu item.



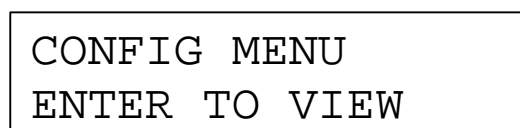
This display gives two pieces of information. The left hand number shows the time of the dose and the right hand number shows the concentration dose. Note that if you ignore the decimal point in most cases the number can be read as ml.



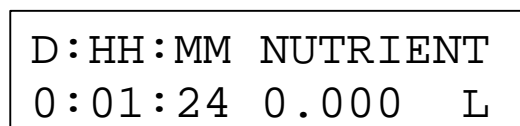
If an alarm is present, this menu item displays the reason for the alarm. See Appendix for a description of alarms.



Press the Enter button to go to a sub menu that allows you to see detailed status information.



Press the Enter button to go to a sub menu that allows you to see set parameters that control how the unit works.



This menu displays the duration in Days, Hours and minutes and the total volume of Nutrient injected during that time.

The time and the nutrient volume are both reset to zero by going to the RESET NUTRIENT LOGGING menu in

the CONFIG sub menu. They are also set to ZERO when the CPU re starts.

The information is not retained if the power is lost from the system.

The example display shows that 1105 milliliters of nutrient have been injected in the last 1 hour and 24 minutes.

### 13.3 DEBUG Menu

To get into the DEBUG menu from the main menu, use the arrow keys to get to the DEBUG menu and then press enter to get into the DEBUG menu. You know when you are in the DEBUG menu because there is a "\*" in the top right of the display. If you are not changing a value, press the ESC key to return to the main menu.

\* indicates  
Debug menu

W PLS 123	*
N PLS 1234	

This menu displays the pulses as they are received. This information can be useful when fault finding. The numbers increases by one each time a pulse is received on the respective input.

Internally 16 bit counters are used. The maximum counts for water and nutrient that will be displayed are 65535. The counters then roll over to zero.

SERIAL	01	*
--------	----	---

Note that RAW PULSE COUNT is displayed NOT proportion and NOT liters.

This menu is used to help with using the serial remote control function. As characters are received from the remote interface they are displayed on the bottom left corner. As a valid message starts to be received, it is displayed across the bottom line.

This menu displays the battery voltage.

BATTERY	*
12.445V	

SYSTEM CURRENT	*
67mA	

This menu displays the total system current.

LAST SOLENOID	*
0mA	

This is the measured current draw of the solenoid when the solenoid was energized on the last dose cycle.

LAST PUMP	*
0mA	

This is the last measured current draw of the pump when the pump was energized on the last dose cycle.

CONDUCTIVITY	*
0uS	
RUN SELF TEST	*

This is the reading from the conductivity sensor.

Press ENTER to run the self test. The result of the test is displayed on the bottom line.

WARNING the self test will inject a small amount of nutrient.

### 13.4 CONFIG Menu

To get into the Config menu from the main menu, use the arrow keys to get to the config menu and then press enter to get into the config menu. You know when you are in the config menu because there is a “#” in the top right of the display. If you are not changing a value, press the ESC key to return to the main menu.

# indicates  
config menu

DOSING MODE	#
NUTRIENT METER	
SET POINT	#
1.00 %	
SET ALARM LEV	#
1.10 %	

This menu is used to select between the two fundamental control modes. These two modes are Timer Mode and Nutrient Meter Feedback Mode.

See section 5 for a detailed description of the two modes.

The SET POINT display is used to set the target dose. If the DOSING MODE is set to TIMER MODE then the SET POINT is in seconds. If the DOSING MODE is set to NUTRIENT METER, then the set point is in percent.

This display is used to enter the level at which the unit will trip out. The display is dependant on the setting of the DOSING MODE.

If the DOSING MODE is set to NUTRIENT METER, then the alarm is in percent.

If the dosing mode is set to TIMER MODE then this menu is not visible and the system will trip out if the pup runs for more than 3 seconds.

Note that Irrespective of the setting of this display, the unit will trip out if the pump runs for longer than 3 seconds when dosing or 15 seconds when priming.

This menu is used to set the number of water meter pulses that are required to trigger a dose. Normally this is set to 1 and a water meter that provides one pulse per 10 litres is used.

WATER CAL	#
1 Pulse/Trig	



NUTRIENT CAL      # 1295 Pulse/L
-------------------------------------

This menu is used to set the number of pulses per litre generated by the nutrient flow meter.

SERIAL ADDRESS # 01
------------------------

This menu is used in conjunction with the serial remote control interface.

01 is the address of the unit. See section Protocol Format.

To change the address of the unit, Press Enter. Then use the up and down arrows to set the address. The address is a two digit number. Press Enter again to store the new address.

Once stored, the address is retained even when power is removed from the unit.

COND MONITOR      # ENABLED
--------------------------------

This menu is used to enable or disable the conductivity monitor function. If it is set to disabled then the unit does not measure conductivity or generate alarms related to conductivity.

COND BLOCK LVL # 1000uS
----------------------------

This menu is used to set the level at which the unit will ignore pulses from the water meter. That is if the conductivity is greater than this level but less than the CONDUCTIVITY ALARM level, the unit will ignore pulses from the water meter until the conductivity drops 10% below this level. This menu is used to set the conductivity alarm level. If the conductivity rises above this level then the unit shuts down into Alarm mode.

COND ALARM LVL # 2500uS
----------------------------

ALARM MODE      # LATCH
----------------------------

PULSE or LATCH is displayed to advise the mode of operation of the Alarm Relay.

To change the mode of operation of the alarm relay, Press ENTER then use the up and down arrows. Press ENTER to store the value or ESC to cancel. The value stored is retained even if the battery is disconnected from the unit.

When set to LATCH, the relay is energized when there is no alarm and de energized when there is an alarm. When set to PULSE, the Alarm Relay pulses on for a couple of seconds once per minute.

REALTIME TEST      # ENABLED
---------------------------------

When set to ENABLED the Nutridose system will check that the solenoid and pump currents are within the limits described in section \_TBD\_ as well as checking that pulses are coming out of the nutrient sensor as the system doses.

RESET NUTRIENT #  
LOGGING

This menu is used in conjunction with the nutrient log on the main menu.

Press ENTER to reset both the time count and the nutrient usage count to zero.

The system will respond asking you to confirm the reset. Press ENTER to confirm or ESC to cancel.

## 14 Appendix 3 Connections

This section describes the physical interfaces on the unit.

### 14.1 Conductivity Probe

Pin

- |   |         |  |
|---|---------|--|
| 1 | PWR     | +12V unregulated DC supply from the battery to the conductivity probe. |
| 2 | GND     | Power Ground.  |
| 3 | RS485 A |  |
| 4 | RS485 B |  |
| 5 |         | No internal connection. Reserved.                                      |

RS485 is a bi directional data interface using 5V logic levels. These lines are used to communicate with the conductivity probe.

The conductivity probe connection uses 9600 bps, 1 start, 8 data, 1 stop bits, No parity.

### 14.2 Solar Panel

These two connections connect to the solar panel.

Pin

- |   |                      |
|---|----------------------|
| 6 | Solar Panel Negative |
| 7 | Solar Panel Positive |

The unit can tolerate the solar panel being connected the wrong way round for a short time without damage. During that time the CHARGE LED will be twice the normal brightness.

### 14.3 Battery

These two terminals connect to the battery.

Pin

- |   |   |
|---|---|
| 8 | Battery Negative - (Also referred to as Ground and GND) |
| 9 | Battery Positive +                                      |

The unit can tolerate the battery being connected the wrong way round for a short time without damage. The unit will not operate in this mode.

An inline fuse should be installed between the battery positive and the battery.

### 14.4 Pump

The +12 V pump is connected across these terminals.

Pin

- |    |   |
|----|---|
| 10 | Pump positive connection. This pin is switched to the Battery+ pin when the unit is in RUN mode.  |
| 11 | Pump negative. Momentarily switched to Ground to turn on the pump. The duration is controlled to obtain the required proportion of nutrient to water. |

**WARNING – DO NOT** connect any wires between the pump and the battery to 'test' the pump. This will damage the 0121 controller. If you wish to test the pump motor, disconnect

BOTH WIRES from the 0121 controller. 0121 controllers damaged by the addition of wires to test pumps are not covered by warranty.

### **14.5 Nutrient Meter**

These three connections connect to the nutrient flow meter. The meter requires positive voltage supply and ground. It returns a digital (0-5V) signal that is read by the microprocessor.

It is designed to interface to a RS 256-225 flow meter.

Pin		
12	GND	Braid
13	+5V Supply to Meter	RED Wire
14	Pulses	BLUE wire

### **14.6 Gate Valve**

A Spray Flow series 2400 or equivalent gate valve is connected across these three terminals.

Pin	
15	GND . Gate Valve ground connection. (WHITE wire)
16	Gate valve control output. ( BLACK wire) When this is at +12V the valve opens. When this is at 0V, the valve closes.
17	+12V supply output to gate valve. (GREEN wire)

### **14.7 Power Relay**

This is a relay output that is used to switch the power of a monitored external system. The relay is energized when the unit is running and de energized when the system is stopped or in alarm mode.

It can switch 12V DC 10A.

Pin		
18	NO	Connected to Pin 20 when all OK
19	NC	Connected to Pin 20 when an alarm is present
20	Common	

### **14.8 Water Meter**

This input is designed to monitor the reed switch detector in the main line water meter.

Pin	
21	GND
22	Data Input from Reed switch.

### **14.9 Solenoid**

These pins are used to connect to the Solenoid. The solenoid opens momentarily before the pump operates and closes when the pump switches OFF.

Pin

23	+ve output
24	-ve. (switched output)

This output has a low side switch (FET) like the pump.

### **14.10 Alarm**

These 3 pins connect to a small telecommunications style relay that is used to indicate an alarm condition to a telemetry system

The relay operates in one of two modes depending on the setting in the ALARM menu.

If the mode is set to PULSE then

When the system is in the alarm state, the relay closes for 5 sec every minute.  
It is intended to key a radio transmitter to transmit the alarm condition as a tone.

If the mode is set to LATCH then

When the system is in the alarm state, the relay is permanently closed.  
In this mode, the alarm would be transmitted via a telemetry system.

Pin

25	NO	Connects to pin 22 when an alarm is present.
26	NC	Connected to pin 22 if no power on the system.
27	Common	

### **14.11 Alarm Tone**

This output provides a tone sequence that can be transmitted over a two way radio to alert the user to a problem with the system. The radio is keyed to the transmit condition using the alarm relay output on pins 21 and 22.

Pin

28	Tone
29	Ground

### **14.12 Serial Remote Control - Comms interface**

This is the physical interface for the remote control interface.

This interface is described in more detail in Remote Control.

Both RS232 and RS485 physical interfaces are provided. They connect to the one UART inside the unit. When the 0121 transmits, the data comes out on both interfaces. When it is listening, it is listening to both inputs. The user should use one or other but not both interfaces.

<b>Pin</b>	<b>Function</b>
30	GND – Comms interface ground pin.
31	RS232 TX Data Output from the 0121.
32	RS232 RX Data Into the 0121.
33	RS485 A
34	RS485 B

Data is transmitted at 9600 bps 1 start, 8 data, 1 stop, No parity.

## 15 Alarms and Fault Finding

The system can display a number of alarms on the ALARM menu.

If the unit is being accessed via the Remote serial interface then a code number is returned.

Remote Alarm Code	LCD Display	
0	NO ALARMS	
1	LOST POWER	The unit lost power. Check the battery and the wiring to the battery. If there is a bad connection to the battery then the voltage can drop too low when the pump runs and this can cause the unit to reset.
2	PUMP ON TOO LONG	The pump was on for longer than the 3 seconds when dosing or 15 seconds when priming. Check that there is nutrient in the tank. Check for a blockage in the injection system Check that the nutrient flow meter is working properly and does not have material deposited inside it. Check if the solenoid or gate valve are jammed closed. Check if the pump is faulty.
3	WATER METER PULSE WHILE PUMP ON	This indicates that a second pulse was received from the water meter before the unit had finished this dose cycle. This can be caused by several factors. a) If the water flow rate is high and the back pressure is high then the system may not be able to deliver the dose in the available time. Upgrade to a larger dosing system.  b) A faulty register in the water meter.  c) Water hammer or other hydrological effect causing the water meter to run back and forward.
4	DOSING PROPORTION HIGH	This alarm can only be generated if the system is running in feedback control mode. Ie when the DOSING MODE is set to NUTRIENT METER and if the proportion as calculated by the unit is greater than the level set in SET ALARM LEVEL menu. The proportion is calculated by taking the number of nutrient pulses, then converting to milliliters using the NUTRIENT CAL factor and then dividing that into 10 litres and then comparing it to the ALARM LEVEL setting.  The first thing to check is whether the nutrient sensor has got material deposited on it as this can cause it to have intermittent operation.

5	LOW BATTERY VOLTAGE	<p>This alarm is generated if the battery voltage is below 10V.</p> <p>Always ensure that a good quality battery in good condition is being used. Batteries need to be replaced every couple of years. Check the water level in the battery and top up with DEMINERALISED WATER if required.</p> <p>Check the solar panel. Even a small amount of shade over part of the solar panel will render the solar panel useless.</p>
6	CHECK NUTRIENT SENSOR	<p>This alarm is generated if during a dose that there are no pulses from the nutrient sensor in any twenty five millisecond period.</p> <p>This can be caused by the sensor being gunked up by deposits in the water. If this error is seen it is CRITICAL to ascertain the source of the problem and to fix it.</p> <p>This may require the nutrient sensor to be replaced.</p> <p>Simply re starting the system may result in a over dose situation.</p>
7	WATER METER PULSE WHILE SOLENOID ON	<p>This alarm is generated if a second pulse was received while the solenoid was open.</p> <p>This indicates that a second pulse was received from the water meter before the unit had finished this dose cycle.</p> <p>This can be caused by several factors.</p> <p>a) If the water flow rate is high and the back pressure is high then the system may not be able to deliver the dose in the available time. Upgrade to a larger dosing system.</p> <p>b) A faulty register in the water meter.</p> <p>c) Water hammer or other hydrological effect causing the water meter to run back and forward.</p>
8	CHECK SOLENOID	<p>The 0121 controller measures the current to the solenoid just before the pump is switched on. If the current is too high or too low then this alarm is generated.</p> <p>The most likely cause is the wire to the solenoid or the solenoid being open circuit or shorted out.</p> <p>(OK Current Range: 250mA -&gt; 3000mA)</p>
9	CHECK PUMP	<p>The 0121 controller measures the current to the PUMP during the dose. If the current is too high or too low then this alarm is generated.</p> <p>The current can be too high if the pump jams, or if the system has a blockage or the back pressure in the water line is too high or if the wire to the pump is short circuited.</p> <p>The current can be too low if the wires are broken or the motor is open circuit. This alarm can be generated if there is no nutrient in the pipe.</p> <p>(OK Current Range: 500mA -&gt; 11000mA)</p>



10	CONDUCTIVITY TOO HIGH ALARM	The 0121 controller measures the conductivity of the water after injection. If the measured conductivity goes above the threshold entered in the COND ALRM LEV menu, then the system shuts down and this alarm is reported.
11	CONDUCTIVITY PROBE NOT RESPONDING	This alarm can only be generated if conductivity monitor is enabled in the CONDUCTIVITY MONITOR menu. This alarm means that the 0121 controller expects to be able to communicate with a conductivity probe but that it is not able to communicate with the probe. Check the wiring to the probe.

## 16 Remote Control

This section describes the remote control and monitoring protocol.

The details of the serial port interface are described in section Serial Remote Control - Comms interface.

### 16.1 Protocol Format

[lead-in][Address][Message][Checksum][Terminator]

Both transmit and receive messages fit this format.

All characters transmitted are printable ASCII with the exception that a CR LF is appended to each response generated by the unit.

The various message elements are defined as follows

[lead-in]	The open curly bracket character '{'
[Address]	The address of the unit in Hex. Addresses can range from 00Hex to FFHex. Two asterisks '**' are recognised as a wild card address.
[Message]	Message characters. Printable ASCII characters.
[Checksum]	Checksum as defined below
[Terminator]	The closed curly bracket character '}' This character terminates the transmission.

### 16.2 Checksum

The checksum operates on the address and message bytes only. It is a single character and is calculated as follows:-

$$((\text{SUM AND } 63) \text{ XOR } (\text{SUM DIV } 64)) + 32$$

Where:

SUM is the modulo 256 sum of the address and message bytes.

AND is the bitwise AND operator.

XOR is the bitwise exclusive OR operator.

DIV is the divide operator.

This is equivalent to saying that the checksum is the eight bit sum of the ASCII values of the address and message characters, with the most significant bits of the result shifted down and exclusive ORed with the two least significant bits of the result. The 32 (space) is added to make the result printable.

## 16.3 Commands and responses

### 16.3.1 C – Stream Conductivity Data

This command repeatedly sends conductivity measurement data out the serial port.

Note that the response is NOT formatted like the other messages. This command is intended to be used in debugging or lab situations where the 0121 is connected to a pc.

Note that this only works when the conductivity sensor is connected to the unit.

Use the D command to switch it off.

Example {01CF}

Once this command is received, the unit streams data in the following format at 10 samples per second.

Example Response: {01 463 1000 2500 0 1 E}

The meaning of this message is made up of the following bits

{	Start of message character.
01	The address of the unit.
463	The measured conductivity value in micro siemens.
1000	The value at which water meter pulses are blocked in micro siemens.
2500	The value at which a conductivity alarm is triggered in micro siemens.
0	The current dose proportion for the dose in percent.
1	The state of the main water meter input
	0 = Water meter contacts closed
	1 = Water meter contacts open
E	The checksum
}	The end of message character.

### 16.3.2 D – Stop streaming data from C command

This command switches off the function initiated with the C command.

Example {01DG}

There is no response on the serial interface.

### 16.3.3 S – Status

The Status command requests that the Nutridose return a message providing its status

Example: {01SV}

The meaning of this message is made up of the following bits

{	Start of message character
01	The address of the unit
S	The status command
V	The checksum
}	The end of message character.

## Example Responses:-

```
{01 S V0A02 C000056DD A00 S03 G01 R01 W000109F0 N000A599F P0064 B349D T018A F00
J00 K00000000 L000002F2 M05C7 O0E5F D0235 X03E8 Y09C4 C}
```

Character	Description
{	Start of message Character.
01	The address of the unit sending the message. 01 in this example.
S	The command received is echoed. Note the space between the address and the echoed command distinguishes a response from a command.
V0A02	The Software version number. Two bytes in hex, the first byte represents the whole integer value of the software version; the second byte represents the fractional value of the software version.  Version 10.02 is shown in this example.
C000056DD	The time count in seconds since logging was reset.
A00	The Alarm Code. One byte transmitted in HEX. When it is zero there are no alarms.  00 = No Alarms 01 = Lost Power 02 = Dosing Proportion High 03 = Check Pump 04 = Low Battery Voltage 05 = Check Solenoid 06 = Conductivity Too High Alarm 07 = Water Meter Pulse While Solenoid On 08 = High Battery Voltage 09 = Conductivity Probe Not Responding 10 = Pump On Too Long 20 = Water Meter Pulse While Pump On 40 = Check Nutrient Sensor

S03	<p>The unit State</p> <p>The State byte determines how the unit responds, this is a bit field. The state of the unit is also reflected in the three LED's immediately below the LCD. The states fields are set by the following.</p> <p>Bit 0 = Alarm mode (Stopped with an alarm condition)  0 = Alarm mode OFF  1 = Alarm mode ON</p> <p>Bit 1 = Run / Stop mode  0 = Run mode (Auto dosing mode)  1 = Stop mode (Stopped by the user, no alarms)</p> <p>Bit 2 = Conductivity Monitoring enabled / disabled  0 = Conductivity monitoring OFF  1 = Conductivity monitoring ON</p> <p>Bit 3 = Current Monitoring enabled / disabled  0 = Current monitoring OFF  1 = Current monitoring ON</p> <p>00 = Run  01 = legacy Alarm  02 = Stop  03 = Alarm  04 = Run &amp; Conductivity  05 = n/a (unexpected)  06 = Stop &amp; Conductivity  07 = Alarm &amp; Conductivity  08 = Run &amp; Current  09 = n/a (unexpected)  0A = Stop &amp; Current  0B = Alarm &amp; Current  0C = Run &amp; Conductivity &amp; Current  0D = n/a (unexpected)  0E = Stop &amp; Conductivity &amp; Current  0F = Alarm &amp; Conductivity &amp; Current</p>
G01	<p>Gate Valve Status</p> <p>01 = Gate Valve Open  00 = Gate Valve Closed</p>
R01	<p>Remote Power Relay Status</p> <p>01 = Energised  00 = De energized</p>
W000109F0	Water Usage logged in the duration indicated in liters.
N000A599F	The Amount of nutrient logged in ml.
P0064	<p>If the unit is in Nutrient Mode then this contains the desired nutrient dose in hundredths of %. The first character will be 'P' in Nutrient Mode.  i.e. P0064 = Nutrient Mode: 1% dose percentage.</p> <p>If the unit is in Timer Mode then this contains the desired pump on time in milliseconds. The first character will be 'Z' in Timer Mode.  i.e. Z03E8 = Timer Mode: 1000millisecond pump on time.</p>

B349D	Battery Voltage in milli Volts.
T018A	Temperature in tenths of a degree C.
F00	Overflow flag.
J00	Pump On Status 00 = Pump Off 01 = Pump On
K00000000	The length of time that the pump has been on in milliseconds (K00000000 if the pump status is OFF).
L000002F2	Pump ON time for last complete injection in milliseconds.
M05C7	The measured Solenoid current for the last dose in milliamps.
O0E5F	The measured Pump current for the last dose in milliamps.
D0235	The last measured conductivity in microsiemens.
X03E8	The user set conductivity value over which water meter pulses are blocked in microsiemens.
Y09C4	The user set conductivity value over which a conductivity alarm is generated in microsiemens.
-	The checksum character.
}	End of message character.

### **16.3.4 X – Stop dosing**

This command will set the 0121 controller to stop mode. The 0121 will close the gate valve and stop dosing.

There is no command to switch it ON. It can only be switched on by pressing the GO button on the front panel.

Response:-The response from this command is the same as for the status command, however "X" is returned in place of "S" in the status return string.

## 17 Tone Pulse Telemetry

The 0121 can be connected to a two way radio or other device to provide notification of an alarm condition.

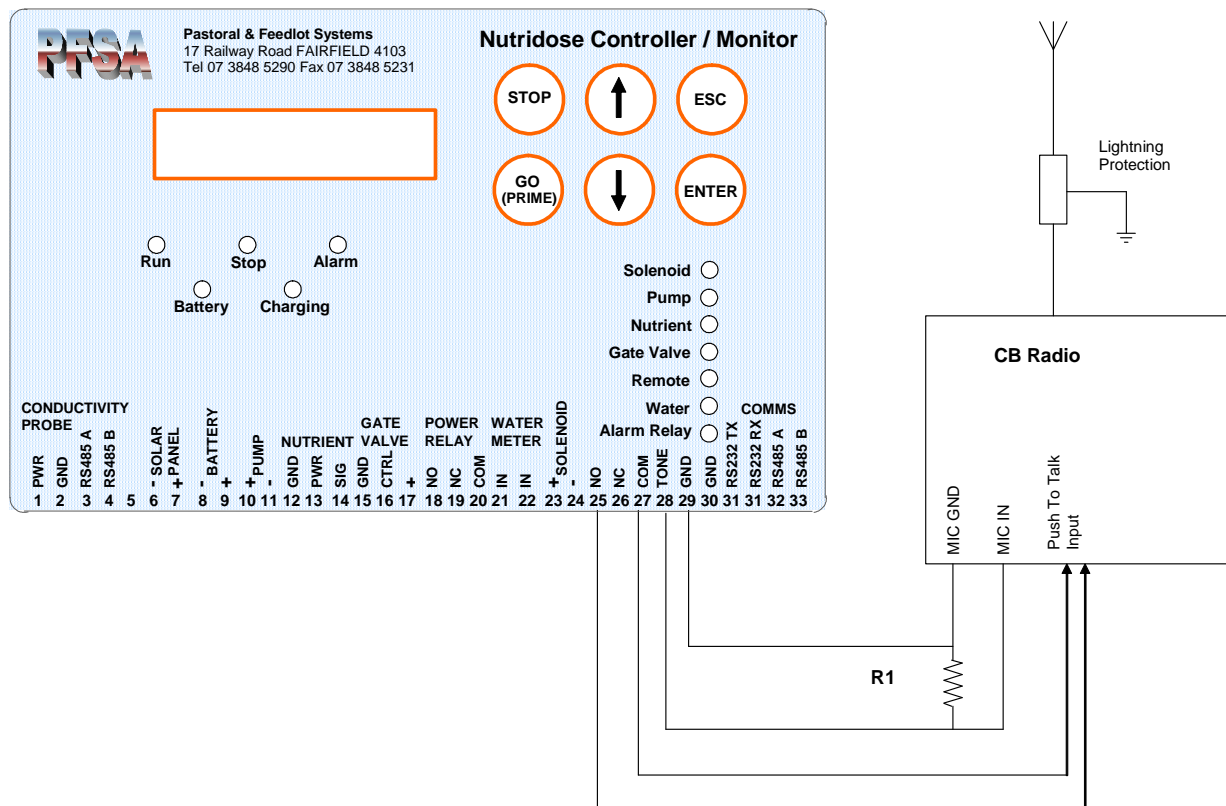
When the unit is in alarm mode the alarm relay is activated.

Note that the operation of the alarm relay can be set to either pulse or latching mode. To transmit a tone sequence, the mode of operation of the alarm relay must be set to PULSE.

The +12V power for the radio can be connected directly from the battery. To conserve power, the radio power can be switched using the POWER relay on pins 18, 19 and 20.

When the 0121 is in the alarm state the tone sequence is generated on pin 28. Once per minute the alarm relay is closed for about 5 seconds across pins 25 and 27. This keys on the transmitter and transmits the tone sequence.

Radios vary in the audio level required. The level out of the 0121 is fairly high. There is a 100k resistor in series with pin 28 inside the 0121. Resistor R1 is selected to reduce the audio level to that required by the particular radio used. The smaller the value of R1 the lower the volume. R1 should ideally be soldered inside the microphone connector but it could also be inserted in the terminal block on the 0121 between pins 23 and 24.





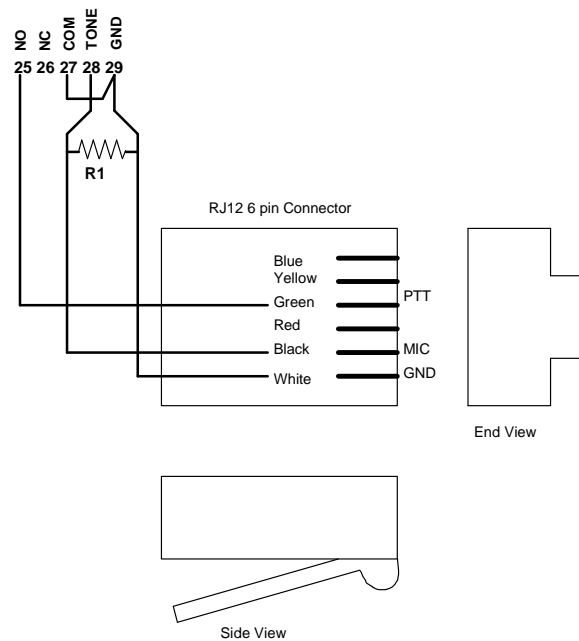
### 17.1 Telemetry – Tone Pulse sequence GME TX3200

The 0121 can be connected to a GME Electraphone TX3200 CB radio.

The connection between the 0021 and the TX3200 is made using a length of 6 wire flat phone lead crimped into a 6 pin RJ12 connector. Note that some RJ12 connectors only have 4 pins fitted but that the full 6 pin version is required in this application.

The value of R1 used in the trial was 470R however the value will still have to be selected to set the desired volume in each application. A small leaded trim pot can also be used.

The RJ12 cable plugs into the front of the TX3200 in place of the microphone.



## 18 Connection as a Controller

This is the standard method to connect the 0121 when it is to operate as a controller.

